APPLICATION

FOR

UNITED STATES OF AMERICA

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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that I,

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have invented certain improvements in:

"DEVICE AND METHOD FOR ADJUSTING THE GRAM FORCE APPLIED TO THE THREAD, FOR FEEDING THREAD TO A KNITTING MACHINE WITH CONSTANT TENSION"

of which the following description in connection with the accompanying drawings is a specification, like reference characters on the drawings indicating like parts of the figures.

The present invention relates to a device and a method for adjusting the gram force applied to the thread, capable of feeding thread of a knitting machine so as to ensure its constant tension.

More particularly, the invention relates to a device and a method for adjusting the gram force applied to the thread to be fed to the knitting machine so as to maintain the tension of the thread always constant, in order to provide a manufactured article of optimum quality.

BACKGROUND OF THE INVENTION

As is known, in knitting machines one of the most important characteristics for the operation of the machine is the gram force applied to the thread, i.e., the tension to which the thread fed to the knitting machine is subjected.

Substantially, if such tension varied suddenly and were not compensated in some way, by rapidly feeding more or less thread to the knitting machine, such thread might break, or otherwise the quality of the knitting would not be optimum, indeed because of the fact that fluctuating variations of the tension of the thread cause the knitting machine to produce an article that does not comply with the required quality standards.

Currently, various solutions are used to adjust the gram force applied to the thread; one of them provides for sensing, by means of a load cell, the gram force applied to the thread, comparing the detected value with a reference value, and issuing a gram force error signal, which in combination with a speed error signal of the motor that controls the unwinding of the spool of thread is used to control said motor so as to accelerate or slow its rotation, thereby increasing or decreasing the thread fed to the knitting machine.

Substantially, the control described above uses two control parameters, i.e., the gram force applied to the thread together with the feed

rate of such thread, i.e., the rotation rate of the motor.

Although this control is effective, it suffers drawbacks caused by the complexity of the sensing of the variables to be controlled, i.e., the gram force applied to the thread and most of all the rotation rate of the motor. The second variable in fact requires the presence of Hall sensors in order to detect the position of the motor and therefore determine its speed at each instant.

This entails a cost as well as a reduction of the reliability of the adjustment device owing to an increased number of components.

SUMMARY OF THE INVENTION

The aim of the present invention is to provide a device and a method for controlling the gram force applied to the thread, in order to feed the thread to the knitting machine so as to ensure that its tension is always constant and conforms with a preset tension set by the machine.

Within this aim, an object of the present invention is to provide a device and a method for adjusting the gram force applied to a thread that substantially allows to predict the behavior of such thread without the need to obtain a precise value for the gram force applied to the thread.

Another object of the present invention is to provide a device and a method for adjusting the gram force applied to a thread in a knitting machine that allows to eliminate speed control yet is able to keep constant the gram force required with any type of thread.

Another object of the present invention is to provide a device and a method for adjusting the gram force applied to a thread that is highly reliable, relatively simple to provide, and at competitive costs.

This aim and these and other objects that will become better apparent hereinafter are achieved by a device for adjusting the gram force applied to a thread in knitting machines, comprising a control unit that is adapted to drive power supply means of a motor for unwinding a thread to be fed to the knitting machine, gram force sensing means adapted to detect the gram

force applied to said thread and to emit a gram force signal, comparator means adapted to compare said gram force signal with a reference signal in order to obtain a gram force error signal, characterized in that said control unit comprises means adapted to emit a signal for driving said power supply means of the motor according to the gram force error signal of said thread and to a signal that is the derivative with respect to time of the gram force signal emitted by said gram force sensor means.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of the device according to the present invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a block diagram of the control device according to the present invention; and

Figure 2 is a chart that plots the behavior of the parameter used to adjust thread gram force.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the figures, the adjustment device according to the present invention, shown schematically as a block diagram in Figure 1 and generally designated by the reference numeral 1, comprises a control unit 2, which is adapted to drive power supply means 3 of at least one motor 4, which is adapted to unwind a thread 5 from a spool of thread in order to feed said thread to the knitting machine 6.

The thread that exits from the spool is passed through gram force sensor means 7, which detect the gram force applied to the thread, i.e., its tension, and emit a gram force signal 8, which is compared in comparator means 9 with a reference signal 10 (refgr.) in order to emit a gram force error signal errgr., which is sent to the control unit 2.

The particularity of the invention consists in that the control unit 2 comprises a controller 11, for example of the PID type, which receives in

input the gram force error signal errgr., together with the derivative of the gram force signal 8 (gr.) that arrives from the gram force sensor means 7.

Substantially, the control unit 2 predicts the behavior of the thread on the basis of the evaluation of the derivative of the gram force signal, designated by the reference numeral 12 in Figure 1, and of at least one threshold, preferably a plurality of thresholds, designated by the reference signs S1, S2 and S3 in Figure 2, set on the gram force error errgr. 9.

The derivative of the gram force signal 12, however, is not calculated here precisely, since it is sufficient to calculate exclusively its sign in order to determine whether the thread 5 is tensioning (with the risk of snapping) or slackening, a situation which entails the need to reduce the rotation rate of the motor.

Therefore, the gram force adjustment device according to the invention uses a single parameter to control the rotation rate of the motor, i.e., the gram force signal 8 obtained by the gram force sensor means 7.

The second signal that is used is a signal that is strictly correlated to the gram force signal 8, since it is the derivative thereof with respect to time.

Accordingly, the adjustment device according to the invention uses, differently from the background art, a single parameter to control the gram force applied to the thread, and therefore the rotation rate of the motor 4, and can be used with any type of thread used by the machine. The fact of not having to determine the exact value of the derivative with respect to time of the gram force signal, merely determining its sign instead, makes the device highly reliable.

With reference now also to Figure 2, operation of the device, and therefore the corresponding method, according to the present invention, is as follows.

First of all the thread 5 is passed through the gram force sensor means 7, which are constituted for example by a load cell and are capable of

emitting a gram force signal 8 that indicates therefore the tension of the thread at a given instant. The gram force signal is compared in the comparator means 9 with a reference gram force, i.e., tension, which is preset for the machine, and the gram force error signal errgr. is then emitted.

At this point, the control unit 2, by using the gram force error signal errgr., together with the derivative with respect to time of the gram force signal 8, and by using at least one threshold or preferably more than one threshold, determines whether the motor 4 is to be supplied with power at the maximum speed, disabled or braked, or whether a control of the PID type is to be performed by means of the controller 11.

Figure 2 shows three separate thresholds of the gram force error, designated by the reference signs S1, S2 and S3. The chart plots the gram force error errgr. on the axis of the ordinates and the type of control to be performed for the motor 4 on the axis of the abscissae.

The curve shown in the chart of Figure 2 represents the error of the gram force signal 8.

As can be clearly noticed, there are different chart regions, designated by the reference letters A, B, C, D, E, F, G, into which said curve is divided.

In particular, in the region designated by the reference letter A, the curve intersects the threshold designated by S1 with a rising trend, and in this region a control of the PID type of the motor 4 is performed.

In the region designated by the reference letter B, the curve instead reaches a maximum, and control of the motor 4 with maximum current is performed in this region.

In the region designated by the reference letter C, the curve of the signal changes inclination and the motor is disabled.

In the region designated by the reference letter D, there is again a control of the PID type, in which the curve transitions from intersecting the threshold S1 to intersecting the negative threshold S2.

In the region designated by the reference letter E, in which the curve

of the signal 8 intersects the threshold S3, the motor control indicates that the motor must be braked.

In the region designated by the reference letter F, instead, the curve of the signal 8 reaches a negative minimum and in this step the motor is supplied with no current.

Finally, in the region designated by the reference letter G, the motor is disabled, as in step C.

The power supply means 3 of the motor 4 modulate, on the basis of the chart shown in Figure 2, the motor current in an open loop, performing only a control of current limiting.

The advantage of this type of control is the maximum promptness in motor response, without delay.

In practice it has been found that the device and method according to the present invention fully achieve the intended aim and objects, since they allow to provide a control with adjustment of the gram force applied to the thread by using a single parameter, i.e., the tension of said thread, without resorting to a detection of the speed of the thread and therefore of the rotation rate of the motor.

The device and the method thus conceived are susceptible of numerous modifications and variations, all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

The disclosures in Italian Patent Application No. MI2003A000892 from which this application claims priority are incorporated herein by reference.